

IV. *The Life-history of Pericoma canescens* (Psychodidæ). By Professor LOUIS C. MIALI, F.R.S., and NORMAN WALKER. *With a Bibliographical and Critical Appendix*, by Baron OSTEN SACKEN, Hon. F.E.S.

[Read Feb. 6th, 1895.]

PLATES III. and IV.

LITTLE appears to be known of the life-history of any members of this family. Short and dry accounts of the larva and pupa of *Psychoda phalænoides* (*nervosa*), which is found on decaying vegetation, are given by Bouché,* Perris,† and Curtis.‡ Fritz Müller has described the peculiar respiratory organs of several larvæ of this family, which occur on wet rock-surfaces at Blumenau (Brazil). He notices in particular that open spiracles and tracheal gills co-exist in them. At the end of the abdomen are two large spiracles surrounded by a circle of hairs, and leading to the tracheal trunks. Each trunk sends off branches to two or three pairs of ventrally placed anal papillæ, which are finger-shaped and retractile, being retracted in air and protruded in water. In one species the larva, on entering the water, sometimes takes down with it an air-bubble, which clings to the hairs around the spiracle.§

The larvæ and pupæ of one species of this family have turned up in considerable numbers in a paved channel receiving over-flow water from the stream at Meanwood, near Leeds. It is found also on the banks of a muddy pond at Adel, near Leeds. The larva feeds upon green algæ, and is found entangled in the filaments. It is wetted with water, and must often be immersed for a long time together. It is not, however, altogether

* Naturg. d. Insekten, pp. 28, 29, pl. ii., figs. 20-22 (1834).

+ Ann. Sci. Nat. Zool., 2^e sér., tom. iii, pp. 346-348, pl. 6B (1840).

‡ Journ. Roy. Agr. Soc., vol. x., p. 403, pl. v., figs. 47-50 (1850).

§ Entom. Nachrichten, Sept., 1888.

aquatic. It breathes air, and often creeps out of the water altogether. This is rather troublesome to anyone who keeps the larvæ in captivity, for they stray from their saucers, if precautions are not taken. Flies reared in the laboratory of the Yorkshire College were sent to Mr. R. H. Meade, of Bradford, who has kindly examined and named them.

DESCRIPTION OF THE LARVA.

The body is 8 mm. long, and consists of a head, followed by eleven segments. Transverse constrictions subdivide the segments. Each thoracic segment consists of two annuli, while most of the abdominal segments consist of three. Traces of a third annulus can be seen in the thoracic segments, but the constriction is not complete. The first abdominal segment has only two annuli, and the eighth is apparently undivided. It is possible that this eighth and last abdominal segment consists of an eighth and ninth fused together, but there is no proof that this is the case.

The body is densely covered with chitinous tubercles, for the most part very minute. These appear under the microscope like nails imbedded in the flexible skin. They take various shapes according to their position, some being long and slender, others stumpy. A prominent rim unites them more firmly to the skin. This external armour is a great obstacle to anatomical examination, and no doubt protects the living animal either from the attacks of its enemies or from abrasion. Inhabiting stony channels and subject to a rush of water bearing silt and gravel with it, the larva may well stand in need of a defensive armour.

The more exposed parts of each annulus are protected by chitinous shields in addition to the tubercles, which here become less numerous. There is a narrow, transversely set dorsal shield to each annulus. Along the middle line of each shield is a narrow patch of tubercles, while its lateral extremities bear processes like parapodia, ending in one, two, or three long and stout setæ. The dorsal shields of the first three annuli are divided along the middle line. The use of this provision appears at the time of pupation, when the integument splits along the very same annuli to allow of the escape of the

pupa from the larval skin. The ventral surface is more uniformly covered with tubercles and setæ. A pair of small and distinct plates, which appear to be more solid than the neighbouring integument, defend the middle annulus of most of the abdominal segments on the ventral side, lying within the shield. The sides of the body bear a flexible armour of regular and close-set setæ, with here and there a larger plate. There is a lateral fringe of much longer setæ, the first annulus of the segment having, as a rule, a pair of single setæ, the second annulus none, and the third a pair of large double ones. It seems probable that these long and stiff hairs, all pointing backwards, like those which project from the dorsal shields, save the larva from being swept away by a sudden rush of water. Buried, as it commonly is, in well-rooted, filamentous algæ, the larva has only to keep its head up stream to offer a most effective resistance to the current, while it will not be seriously hindered in travelling head-first through the weeds.

The eighth abdominal segment is defended above and on the sides by a single large shield, which bears a median pair of long setæ, and three pairs of lateral ones. The ventral side is more flexible, but is protected by a centrally placed scutcheon and two small lateral plates. Two pairs of long setæ are borne upon the hinder edge of the scutcheon. Close behind this is the anus, which is shut in on the sides and in front by a pair of plates. The extremity of the abdomen is truncated. It bears four large anal processes, two dorsal and two ventral. Between the bases of these processes, but nearer to the dorsal pair, are the posterior spiracles. The anterior spiracles are borne on the sides of the second annulus of the prothoracic segment. They project as cylindrical tubes with circular, terminal openings, and wrinkled bases. Anterior spiracles are unusual in aquatic Dipterous larvæ, but *Eristalis* furnishes us with another example. In *Eristalis* the anterior spiracle is probably not functional; in *Pericoma* it apparently is.

The two pairs of anal processes are similar in construction, but the ventral ones are rather longer than the dorsal. Each process consists of a stout chitinous rod bearing a fringe of fine filaments, which project from the sides and tip. The terminal filaments are the longest, and those on the inner side towards the base of the rod the shortest. The anal processes stand out from

a dorsal projection of the eighth segment, which overhangs the anus. Each filament is set with very fine hairs, so that it somewhat resembles a plume.*

The larva may often be seen to run the anal filaments through its mouth, thus cleansing them from diatoms, desmids, etc., which are probably devoured.

The head is rather small, and completely exserted. On its upper surface the triangular clypeus, pointed behind, occupies a central position; it is flanked by the two epicranial plates; all are ornamented with a symmetrical pattern of numerous tubercles. The minute antenna ends in several short rods of equal size and similar shape. On the sides of the head behind the antennæ are the eye-spots, which are oval, convex, and pigmented. The labrum is prominent, setose, and very movable, being continually flexed and extended by the living larva. On either side of the labrum, and closely applied to it, is a jointed setose appendage. The mandibles are strong, bent at an elbow, and palmate, each with five pointed teeth; there is a bunch of setæ on the elbow, and also a row of setæ on the inner side. When closed, the mandibles do not interlock, but are rotated so far backwards that their bases are in front and the teeth behind, the elbow then appearing upon or near the margin of the head. Two lobes, each bearing two bunches of setæ and stiffened by several chitinous plates, appear to represent the maxillæ. The submentum is a transverse comb-like plate with about twenty denticles, which increase in size outwards, the most external being three times the size of the next. In front of this comb are the openings of the salivary ducts and a hairy patch, which is the free end of the labium. All the mouth parts are enclosed in a sunk and roughly hexagonal space, which occupies the fore part of the ventral surface of the head. The margin of this space is stiffened by a special rim.

The larvæ seem most at home in water just deep enough to cover the body. They then bury themselves in mud, sand, or algæ, bringing the tip of the abdomen to the surface of the water. The outspread fringes of the four processes then form a cup, filled with air, and from this air can be taken into the spiracle. A larva

* The larvæ of *Pacilostola* (Brauer, Zweifl. d. Kais Museums, iii., fig. 11) has two pairs of similarly placed processes, shortly fringed at the extremities only.

which has comfortably established itself in this position will remain feeding beneath the surface for many hours together, its body being concealed, and its respiration unimpeded. It can travel slowly along the bottom without closing the cup, but there is little need for locomotion.

Under natural conditions this tranquil mode of life is liable to be interrupted by heavy rain, which may cause a sudden deepening of the water, and a great increase in the force of the current, if the larva should inhabit running water. The larva has several alternatives under difficult circumstances. It can cling to the weeds and remain submerged for hours. It can leave the water altogether and creep upon the wet herbage. Or it can float at the surface, if the water is still. In each case it can keep up either a free, or at all events a limited, respiration, and prevent its spiracles from being wetted with water. When the water is made to rise above a larva entangled at the bottom of a saucer, the spiracular cup closes in, and a large roundish bubble forms, which is securely held by the plumose filaments. The bubble is large, as compared with the air contained in the tracheæ, and no doubt suffices to maintain respiration for a long time. If the larva is quite free, as, for instance, if it is placed in a saucer filled with water only, the bubble brings it to the surface, and then breaks, when the floating cup is at once reformed. If a larva, floating by means of its spiracular cup, is forcibly submerged, it takes a large bubble down with it.

The floating cup, formed by radiating filaments lying in the surface-film, which buoys up the tail-end of the larva of *Pericoma*, finds a tolerably close parallel in some other aquatic larvæ. The larva of *Stratiomys** exhibits an anal coronet, which answers the same purpose. The *Stratiomys* larva possesses one advantage, viz., the power of quitting the surface at pleasure, which is not shared by *Pericoma*. The larvæ of *Dixa*† and *Anopheles*‡ come still closer to *Pericoma*, though the details of the mechanism are different. All the above larvæ are Dipterous, but among the Coleoptera we find the same contrivance. The carnivorous larva of *Hydrobius fuscipes* has a floating basin filled with air at the tail-end, which supplies the tracheæ, while the head is swept to and fro in search

* Swammerdam, *Biblia Naturæ*, pl. xxxix.

† Miall, *Nat. Hist. of Aquatic Insects*, p. 157 (1895).

‡ Meinert, *De eucephale Myggelarver*, p. 24 (1886).

of food. *Helophorus* and some other aquatic Coleopterous larvæ might also be quoted.

A rather amusing application of capillary forces is witnessed if we bring a clean needle, half-immersed in water, near to the spiracular cup of a floating *Pericoma* larva. The cup is so strongly attracted that the body of the insect can be dragged about as if glued to the needle. This is the handiest way of submerging a larva. If two floating larvæ are brought near one another, the bubbles cohere and run into one; then the larvæ are glued together, tail to tail, and cannot, so long as they float, disengage themselves. These are mere curiosities, and have nothing to do with the behaviour of the larva under natural conditions. What is practically important is that the larva, when it clings to the bottom, as it almost invariably does, should be able to breathe uninterruptedly so long as the water is shallow; and if the depth is much increased, should be able to retain a bubble of sufficient size to support respiration until it can adapt itself to the change of level.

Three types of larvæ, probably belonging to as many distinct species, occur at Meanwood and Adel. That of *P. canescens* has relatively large anal processes. A second (undetermined) species has a larva of about the same size, with relatively small processes. In a third (undetermined) species the larva is only about half as long, while the anal processes are relatively intermediate in length.

When the time of pupation is at hand, the larva quits the water. It either burrows into the bank or climbs upon a stone which rises well above the water, and there pupates. One favourite habitat of the larva, that is, the thick felted mass of algæ covering earth or stones in very wet, but not submerged places, serves equally well for the pupa, and it often remains there until the fly emerges.

The pupa of *Pericoma* is $3\frac{1}{2}$ mm. long, and much resembles those of many other Tipulidæ. It is provided with a pair of prothoracic respiratory trumpets, which are club-shaped, with a short stalk and a cylindrical terminal part, which is much longer and wider than the stalk. The stalk is transversely wrinkled. The surface of the rest of the trumpet is roughened by many small prominences. A large trachea traverses the organ, and opens by a double row of circular foramina, which extends along the rounded extremity of the trumpet and a little way down its inner side.*

* Cf. *Dicranota*, Trans. Ent. Soc., 1893, pl. xiii., fig. 34.

The legs of the fly, enclosed in their pupal sheaths, are short, and, though extended at full length, do not reach beyond the second abdominal segment.

As in many other pupæ of this and other orders, the abdominal segments are roughened by spines. Each segment bears a prominent circle of large spines and dense patches of smaller ones.

The circles of hooks upon the abdominal segments of the pupa, serve, as in many like cases, as means of locomotion. The pupa can thus place itself favourably, and preserve the most convenient attitude, viz., with the head and respiratory trumpets uppermost. Pupæ kept in dishes are able to creep up the steep and polished sides, and make their escape. When placed in water, they float at the surface, the respiratory trumpets breaking the surface-film. The body is then inclined at an angle of less than 45° with the surface of the water, and the orifices of the respiratory trumpets being obliquely truncated, lie in the surface-plane. The abdomen is flexed and extended at intervals, and can also be bent a little to either side.

We have found it so laborious and yet so necessary, when dealing with the life-history of any insect, to refer to the writings of earlier naturalists who have described the same or nearly allied species, that we gladly present as an Appendix, the following Bibliography of *Psychodidæ* (early stages), with critical remarks, which we owe to the great kindness of Baron Osten Sacken:—

APPENDIX.

I.—LITERATURE OF THE EARLY STAGES OF PSYCHODIDÆ.

(In chronological order.)

1. SCHRANK, F. P., Beitr. z. Naturgesch., 1776. In my manuscript notes I find this article connected with *Pericoma ocellaris*, Meig., the pupa of which is said to be figured in it. I do not remember where I found this reference, and cannot verify it now. It may be the same as Schrank, No. 2, in Hagen's Bibliotheca; Beschreibung einer Mücke. (*Tipula*, with fig.)

2. BOUCHÉ, Naturg., etc. (1834), p. 28, Tab. ii., figs. 20–23. *Psychoda phalænoides*, Meig., i., p. 104. Bouché adds the reference: *Tip. phalænoides*, Linn. But according to the present nomenclature by Haliday

and Schiner, *P. phalænoides*, Meig., is now called *P. sex-punctata*, Curtis, and *P. phalænoides*, Linné, is considered as a separate species, of which *P. nervosa*, Meig., Perris and Curtis (in 1850), are synonyms. (Compare the criticism of Bouché's statements given in the condensed account, below.)

3. V. ROSER, Corresp. Blatt. d. k. Württ. Landw. Ver. (1834), i., p. 261, footnote referring to *P. palustris*, Mg. It contains nothing but the words: "I have found the larva under a decayed mushroom." As *P. palustris* is a *Pericoma*, and the larvæ of this genus, as far as known, are aquatic, the determination of the species seems to be doubtful.

4. PERRIS, Ann. d. Sc. Nat., 2^e Sér., vol. xiii., pp. 346-348 (1840); Tab. vi., fig. B. *Psychoda nervosa*, M. (now called *P. phalænoides*, Linné). The pupa represented is that of *Psychoda*; the larva belongs to some other family. (Compare the condensed account, below.)

5. ERICHSON, Bericht, etc. (1840), p. 86. He calls attention to Perris's figure of the larva, and points out its discrepancy from that of Bouché. (Compare the condensed account, below.)

6. WESTWOOD, Introd., etc., ii., p. 521 (1840). Detailed description of a pupa of a *Psychoda*, sent by Mr. Thwaites, and found in a dead snail's shell.

7. GIMMERTHAL, Arb. d. Naturf. Ver. zu Riga, vol. i., p. 326 (1848). *Psychoda humeralis*, M., bred from a larva feeding on rotten potatoes. (Compare the criticism in the condensed account, below.)

8. SCHOLZ, Schl. Ent. Zeitschr. (1849), p. 20. Contains nothing but a reference to v. Roser. (Compare No. 3.)

9. CURTIS, J., Journ. Roy. Agric. Soc., vol. x., p. 403, Tab. v., figs. 47-50 (1850). *Psychoda nervosa*, M. (*phalænoides*, Linné). A few words about the larva bred from rotten potatoes; the appended figures represent the pupa in three positions.

10. HALIDAY, A. H., in F. Walker's Ins. Brit., Dipt. iii., pp. 253-263 (1856). (Compare the condensed account, below.)

11. ———, Nat. Hist. Review, July, 1857, "On some remaining blanks, etc." Contains, on p. 182, a list of references to publications on the metamorphosis of *Psychoda*. *P. humeralis*, Gimmerthal, is wrongly referred to the genus *Pericoma*.

12. BRAUER, F., Denkschr., etc., vol. xlvi. (1883).

Systematische Studien auf Grundlage der Dipteren-Larven, nebst einer Zusammenstellung von Beispielen aus der Literatur derselben and Beschreibung neuer Formen. On p. 20 the larvæ of the *Psychodidæ* are characterized as follows:—"Larve walzig, amphipneustisch, das hintere Ende in eine kurze meist fest chitinisirte Athemröhre verlängert. Ober- and Unterkiefer am Grunde verwachsen, theilweise zugleich beweglich. Augenflecke am Kopfe vorhanden. Am Ringe hinter dem Kopfe kein Fuss. Nymphe ruhend, vorne mit zwei langen athemröhrtartig verlängerten Vorderstigmen, Athemhörnern. Larve in Bächen und einige Arten in jauchigem Wasser von Cloaken und Aborten." This is all that Brauer gives on this subject.

This statement is incomplete, and contains a contradiction. The description of the larva with the chitinized tail merely refers to the larvæ of *Psychoda*, in the narrower sense of Haliday. The alleged habitat "running and putrid waters," is applicable to the aquatic larvæ of *Pericoma* only, which, as Haliday has shown, are provided with various forms of branchial and other appendages, adapted for aquatic life. Larvæ of *Psychodæ* are found in rotten mushrooms and potatoes. In another part of this work (p. 52), the necessary references are given, and among them, that to Walker's *Ins. Brit.* But no use is made of these references, except that the passage about *Ulomyia* (Walker, p. 261) is incorrectly translated. The erroneous statements of Bouché, Perris, and Gimmerthal, are neither noticed nor criticized. The statement about *P. humeralis*, "nach Haliday eine *Pericoma*," is, as I have shown above (No. 11), based upon a *lapsus calami* on the part of Haliday.

13. LUCAS, H., Bull. Soc. Ent. de France, 1885, p. xliii, communicates some observations on *P. phalænoides*, which, in January of that year, appeared in large numbers in a privy. The larvæ, before changing into pupæ, crawled up the pipe, emerging through its upper opening, where many exuviæ of the pupa were found.

14. MÜLLER, Dr. Fritz, Entomol. Nachr., vol. xiv., pp. 273-277 (1888). Larven von Mücken und Haarfluglern mit zweierlei abwechselnd thätigen Athemwerkzeugen, 3 woodcuts. Describes and figures the tail-ends of the larvæ of two species of *Psychodidæ*, showing the combination of the ordinary pair of anal spiracles with branchial and other respiratory appendages.

II.—CONDENSED ACCOUNT OF OUR PRESENT KNOWLEDGE OF THE EARLY STAGES OF PSYCHODIDÆ, WITH CRITICAL REMARKS ON SOME OF THE PUBLICATIONS.

(The numbers quoted in brackets refer to the preceding List of the Literature.)

Our present knowledge of the larvæ of *Psychodæ* we principally owe to Haliday. His results are incorporated in the chapter on *Phlebotomidæ*, as he called the family, in Walker's *Insecta Brit.*, Dipt. iii., pp. 253–263 (1856). On p. 253, Walker says:—"I am indebted to Mr. Haliday for all the following characters of the genera and species of this family."

The different groups of the larvæ are characterized as follows:—

Larva pale, terrestrial, the last segment slender, much elongated . . . *Psychoda* (Latr.), Hal.

Larva blackish, last segment little elongated, jagged at the end and ciliated with radiating hairs.

Larva with two double rows of lanceolate (gill-like) plates down the back.

Ulomyia, Hal.

Larva with two bands of curved hairs down the back *Pericoma*, Hal.

Further details on the larvæ of the first group, *Psychoda*, are given on the following pages:—

(P. 255.) "The larva of *P. phalænoides*, and that of *P. sexpunctata* * inhabit dry cowdung; they are long, subfusiform, depressed, with a slender, straight, cylindrical tail, which is longer than the preceding segment. The pupa has two short appendages, thickened at the tips behind the head; the abdomen is tapering."

(P. 256, under the heading of *P. sexpunctata*, Curtis.) "Respiratory auricles of the pupa filiform, curved, communicating with the main trachea by a dilated cylindrical portion of the latter. In the larva ready for transformation they may be seen, through the skin, forming an interrupted ring round the first part of the prothorax, beginning close to the spiracle and bent down till they nearly meet below, the thickened part of the trachea being also visible. According to my observations the

* The synonymy of the two above-mentioned species is, according to Haliday (p. 255):—*Psychoda phalænoides*, Linn. (syn. *P. nervosa*, Meig., Perris). *P. sexpunctata*, Curtis (syn. *P. phalænoides*, Meig.).

main tracheæ rise from the prothoracic spiracles to the anal points without any intermediate lateral spiracles, as Perris has already stated, differing from Bouché. I found in the larva a pair of glands (ending in a filament at each end), lying loose among some elongate, cylindric, white, fatty masses in the neighbourhood of the small intestines, nearly as in *Tipula*. These are rudiments of reproductive organs." (Hal.)

In regard to the position of the spiracles, Haliday, in the above quoted passages, agrees with Perris (No. 4), and notices the errors of Bouché (No. 2), who describes and figures them as peripneustic. But, in the same passages, Haliday does not take notice of the structure of the posterior end of the larva figured by Perris; it is truncate, and has no tail-like prolongation, and therefore cannot be a larva of *Psychoda*, in the sense of Haliday. It is only one year later ("On some remaining blanks, etc.," 1857, No. 11), that Haliday, now better informed, says in a footnote (p. 182), "Perris has figured a larva which undoubtedly belongs to some other family of Diptera." The same doubt had already arisen in Erichson's mind (No. 5), in 1840, the very year of Perris's publication, and in his "Bericht" he called attention to the discrepancy between Bouché and Perris; he said, "We can only assume that one of the observers had the wrong larva. Besides other not unimportant differences, the position of the spiracles in Perris is the same as in the larvæ of the *Muscidæ* (Fliegenlarven), that is, there is one pair in front, and one behind. Bouché's larva, on the contrary, has a pair of spiracles on each segment, just as the other Diptera in the division to which *Psychoda* belongs." In this case Erichson was mistaken; he was thinking of the *Mycetophilidæ* and *Cecidomyidæ*, which are peripneustic, and forgot that among the *Nemocera* there are several families the larvæ of which are *not* peripneustic. It is not easy to guess where Perris's larva belongs. It might be taken for that of a small Tipulid, but the larvæ of this family are *metapneustic*, and do not show such a distinct anterior pair of spiracles as is represented in Perris's figure. (I cannot compare the figure now, but I possess a tracing which I made many years ago.)*

* My statement in the Berl. Ent. Zeits., 1892, p. 462, that the larva may belong to some *Muscid*, was a *lapsus memoria* produced by an indistinct recollection of Erichson's allusion to "Fliegenlarve."

The larva of *Psychoda humeralis*, Meig., found by Gimmerthal (No. 7) in rotten potatoes, answers the description of the terrestrial-tailed larvæ, as given above. The species to which it belongs is a *Psychoda* in the narrower sense. (It was a *lapsus calami* on the part of Haliday, as I have already shown above, sub Nos. 11 and 12, when he placed it among the *Pericomæ*.)

When Gimmerthal says, "the spiracles are plainly visible along the sides, as in a caterpillar," he must have been misled by Bouché. I have had occasion to observe a larva of the same group in North America, and found it to be amphipneustic. In a MS. note among my papers I find stated, "the anterior spiracles of the first thoracic segment are very apparent in the shape of short tubes. Large tracheal trunks can be seen distinctly running into the tail. The body is dirty whitish, with extremely short, erect bristles; there were no lateral bristles like those figured by Bouché. The segments are marked by distinct incisures and transverse wrinkles."

The larvæ I have been hitherto discussing belong to the group of the terrestrial-tailed larvæ of *Psychoda* in the narrower sense of Haliday. It remains for me now to reproduce the passages of Walker's Ins. Brit. concerning the larvæ of *Pericoma*, Haliday, and *Ulomyia*, Haliday. They are:—

(P. 256.) *Pericoma*. "Larva with rows of hairs; inhabits water; bent into a ring; the tufts of curved hair detaining a covering of mud."

(P. 260.) *P. nubila*, Meig. "Reared from larvæ found on fallen leaves, immersed in the water of pools or slow streams."

(P. 261.) *Ulomyia*. "The larva lives in clear, running water, and has, like a dorsibranchial *Annelid* or *Phyllo-doce*, down the back two rows of acute, lanceolate, foliaceous, branchia-like appendages; each row consists of three pairs on each segment, viz., a pair on each of the three folds or subdivisions of the segment. Otherwise most like the larva of *Pericoma*. *Ulomyia hirta* was reared from larvæ found on fallen leaves lying in a waterfall of a clear rivulet."

Dr. F. Müller (No. 14) in 1888 described and figured two Brazilian aquatic larvæ, belonging perhaps to as yet undescribed genera of the same family.

EXPLANATION OF PLATES III. and IV.

Pericoma canescens.

PLATE III.

- FIG. 1. Larva, dorsal view, *as.*, anterior spiracle, $\times 20$.
2. Larva, ventral view, $\times 20$.
3. Pupa, ventral view, $\times 20$.

PLATE IV.

- FIG. 4. Anterior annulus of abdominal segment of larva, dorsal view, $\times 75$.
5. Last abdominal segment, with one pair of fringed anal processes, dorsal view, $\times 50$.
6. Last abdominal segment, end view, showing two pairs of anal processes, $\times 50$.
7. Last abdominal segment, end view, showing posterior spiracles, $\times 100$.
8. Head, underside, showing *lbr.*, labrum ; *at.*, antenna ; *mn.*, mandible ; *mx.*, maxilla ; *oc.*, eye-spot ; *sd.*, salivary duct ; *sm.*, submentum, $\times 150$.
9. Extremity of mandible, $\times 300$.